



# Effect of Plant Growth Regulators on Growth and Quality Flower Production of Chrysanthemum (*Chrysanthemum Indicum* L.)

Md. Ehsanullah, Ahasan Ullah Khan\*, Md. Kamruzzam, and Sarah Tasnim

Received : June 29, 2021

Revised : November 5, 2021

Accepted : November 10, 2021

Online : November 11, 2021

## Abstract

A field study was conducted to assess the effect of plant growth regulators on growth and quality flower production of chrysanthemum at Horticulture Research Centre (HRC), Gazipur, Bangladesh. The experiment was laid out in Randomized Complete Block Design (RCBD) with ten (10) treatments and three replications. The treatments of plant growth regulators concentration were T<sub>1</sub>-50 ppm GA<sub>3</sub>, T<sub>2</sub>-100 ppm GA<sub>3</sub>, T<sub>3</sub>-150 ppm GA<sub>3</sub>, T<sub>4</sub>-400 ppm CCC, T<sub>5</sub>-600 ppm CCC, T<sub>6</sub>-800 ppm CCC, T<sub>7</sub>-250 ppm MH, T<sub>8</sub>-500 ppm MH, T<sub>9</sub>-750 ppm MH and, T<sub>10</sub>-Control. The maximum spreading of plant (27.0 cm) was observed when plants were treated with GA<sub>3</sub> @ 150 ppm where the minimum plant spread (16.8 cm) was recorded in plants treated with CCC @ 800 ppm. The higher number of suckers (33) per pot was produced when pots were treated with GA<sub>3</sub> @ 150 ppm whereas, application of CCC at three different concentrations produced lower number of suckers. The highest number of flower (40) was recorded with 150 ppm GA<sub>3</sub>, where minimum number of flowers (25) per pot in 800 ppm CCC. The plants sprayed with 50 ppm GA<sub>3</sub> took 48 days to flower initiation, whereas, it took 70 days with 750 ppm MH. the highest plants recorded (7.40 cm) with 800 ppm CCC, whereas, lowest size (6.50 cm) was obtained with the application of 500 ppm MH. The maximum vase life of flowers was recorded for the treatment 800 ppm CCC (15 days), which was at par with 13 days vase life obtained by spraying 600 ppm CCC. Therefore, it is concluded that the GA<sub>3</sub> acted as growth promoter and the CCC acted as growth retardants on yield and quality of chrysanthemum.

**Keywords:** chlormequat chloride (CCC), flower, Gibberellins (GA), growth promoter, meleic hydrazide, production

## 1. INTRODUCTION

Chrysanthemum (*Chrysanthemum indicum* L.) is a widespread saleable attractive importance flower crop belongs to the family Compositae or Asteraceae, sub family Asteroideae, order Asterales, subclass Asteridae, tribe Anthemideae. It is significant as floricultural, ornamental and medicinal used in modern time [1]–[3]. This flower crop is native to East Asia and has been grown in garden for more than 2500 years [4]–[6]. It is globally the second economically most vital floricultural crop following rose, and one of the most significant ornamental species [2]. It is one of the most important ornamental crops around the world, it is produced as both cut flower in field and pot plant [7]. Many plants, which have been

identified as yet through pharmacology, folk medicine [8], homoeopathy and ethnopharmacology [9], are being investigated for their medicinal usage and may be proved so in due course of time. The *C. indicum* flower is a good source of common quercitrin and myricetin, which is significant for the progress of possible pharmaceuticals [10]. The flower of the *C. indicum* contains major 3 oils viz 1,8-cineole, camphor, borneol and bornyl acetate [11]. This crop use as nerve sedative, anti-oxidant, anti-inflammatory, anti-mutagenic, anti-microbial, anti-fungal, anti-angiogenic, anti-atherosclerosis and nematocidal goods [12]. The leaves remedy and use as colds, headache, bronchitis, rheumatism, swellings, boils and expectorant, bitter and stomachic, respectively. The *C. indicum* flower has a strong aroma and many of the previous studies focused on the essential oil of this plant [13]–[15]. Khan et al. [16] observed that the plant height (54.0 to 66.0 cm); number of leaves per plant (208-240); leaf size (4.5 to 8.5 cm); plant spread (19.0 to 32.0 cm); number of branches (4 to 12); number of flowers (25-40); stalk length (8.8 to 13.3 cm) and days of first flowering (55 to 70 days) varied; respectively in T<sub>7</sub> (100% rice husk) to T<sub>3</sub> (100% cocodust). The different color of leaves and flowers in chrysanthemum flower crop and also the maximum flower period was observed early December-February in germplasms. Taweesak et al.

## Copyright Holder:

© Ehsanullah, Md., Khan, A. U., Kamruzzam, Md. and Tasnim, S. (2022)

## First Publication Right:

Journal of Multidisciplinary Applied Natural Science

## Publisher's Note:

Pandawa Institute stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

## This Article is Licensed Under:



**Table 1.** Variables

Treatments	Plant growth regulators
T <sub>1</sub>	50 ppm GA <sub>3</sub>
T <sub>2</sub>	100 ppm GA <sub>3</sub>
T <sub>3</sub>	150 ppm GA <sub>3</sub>
T <sub>4</sub>	400 ppm CCC
T <sub>5</sub>	600 ppm CCC
T <sub>6</sub>	800 ppm CCC
T <sub>7</sub>	250 ppm MH
T <sub>8</sub>	500 ppm MH
T <sub>9</sub>	750 ppm MH
T <sub>10</sub>	Control

[17] observed that the irrigation effect on plant height of chrysanthemum. The growth of chrysanthemum grown in two soilless systems included tray system and trough system. No significant differences in flower characteristics were observed between the two systems except for flower color.

The commercial cultivation of chrysanthemum with good quality flowers and higher yield is needed for consumption in local market and to provide livelihood especially to the marginal and small farmers [18]. Good quality flower production depends upon various factors such as genotype, environment, spacing, disbudding, pinching, substrate, use of growth regulator etc. [19]. Plant growth regulators (PGRs) are now being commonly used for inducing more acceptable plant characteristics like compact growth, dwarfness, increased number of healthy branches and promote flower initiation [20]. Similarly, pinching of apical bud has a significant influence on flowering and yield [21]. Thus, growth regulators and pinching can play an important role in the improvement of flowering and yield of Chrysanthemum. Keeping in view the above points the present experiment was undertaken to compare the effects of growth regulators and hand pinching for higher flower yield in chrysanthemum. Gibberellins (GA<sub>3</sub>) play an important role in growth and flowering of ornamental plants. Foliar application of gibberellic acid enhances vegetative attributes along with flower initiation [22]. An experiment was

conducted by Dorajeero and Mokashi [22] and noted that foliar allocation of 3000 ppm CCC produced maximum number of flowers per plant, as compare to other concentrations. The plant growth regulators promote growth and yield in ornamental plants. Keeping in view the above points the present investigation, plant growth regulators has been evaluated on the growth, and quality flower production in chrysanthemum crop. The general objective of this study is to assess the growth regulators for quality flower production of the chrysanthemum.

## 2. MATERIALS AND METHOD

### 2.1. Materials

#### 2.1.1. Experimental Site

The present investigation was carried out at the experimental farm of Landscape, Ornamental and Floriculture Division, HRC, BARI, Gazipur during the period from July 2007 to June 2008. The study area situated in 23.9917° N longitude and 90.4137° E latitude at an altitude of 9 meter above the sea level.

#### 2.1.2. Planting material

Seed of genotype of CM-022 were used in the experiment during the period from July 2007 to June 2008.

### 2.2. Methods

#### 2.2.1. Pot preparation and Treatments

The experiment was conducted in earthen pots of 12 cm size. The pots were washed and cleaned thoroughly before filling up of potting media. In this planting media using plant growth regulators like Gibberellins (GA), Chlormequat Chloride (CCC) and Meleic Hydrazide (MH) concentration.

There were ten treatments in the experiment, comprising different plant growth regulators in quality flower production of chrysanthemum (Table 1). The treatment of plant growth regulators concentration used in the experiment were 50 to 750 ppm.

#### 2.2.2. Design and layout of the experiment

The experiment was laid out in Randomized

Complete Block Design (RCBD) with three replications. One plant was planted in a pot, containing the potting media according to the treatments and five plants were constituted the unit of treatment.

### 2.2.3. Seedling raising, transplanting and fertilization

Primarily cuttings of CM-022 were prepared for planting in the sand in mid-August, 2007. Immediately after rooting, the mini plantlets were transferred to pot containing media that consists of one-part coarse sand, one part garden soil, one part cocodust, one-part cowdung, a quarter part of wood ashes and two table spoonfuls of bone meal in mid-September, 2007. Subsequently 10 g TSP and 3 g MP per pot were applied. Urea @ 2, 3 and 3 g per pot was applied at 20, 30 and 40 days after transplanting respectively for getting best growth and flowering of plants [23].

### 2.2.4. Irrigation and weeding

Weeding and mulching were done in the pots whenever it was necessary to keep the pots free from weeds. Chrysanthemum plants need frequent irrigation. The pots were irrigated every alternate day to keep the media moistened.

### 2.2.5. Staking of plant

Each plant was supported by 40 cm long bamboo stick to facilitate the branches of the plant

to keep erect. The plant in each pot was fastened loosely with the bamboo stick by jute string to prevent the plant from lodging.

### 2.2.6. Harvesting of flowers

The spikes were harvested when the flower attained commercial stage (Flower open before shedding of pollens from the outer row of the disc florets).

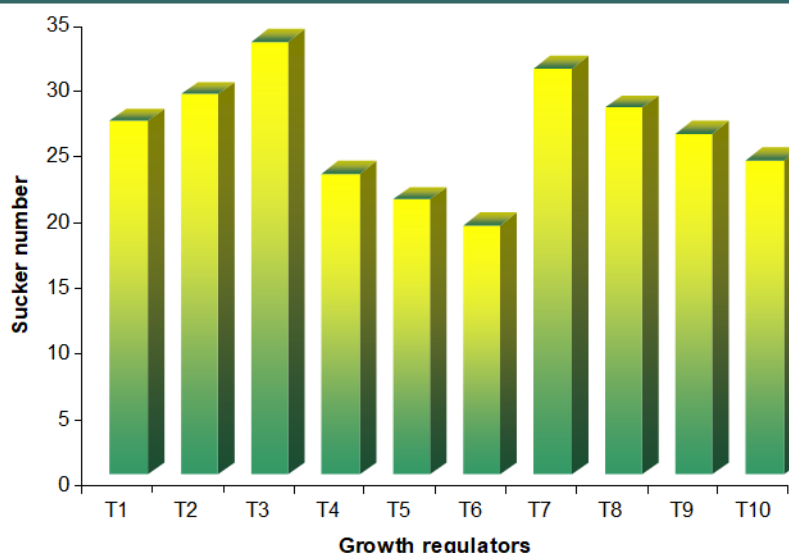
### 2.2.7. Collection of data

Data were collected on the following parameters for interpretation of the result of the experiment. The parameters were number of leaves plant<sup>-1</sup>, plant spread, Number of suckers plant<sup>-1</sup>, Leaf length, Number of branches plant<sup>-1</sup>, Days to flowering, Stalk length, Number of flowers plant<sup>-1</sup>, and Flower size. *Number of leaves plant<sup>-1</sup>*: Number of leaves per plant was recorded by counting all the leaves from 5 plants and the mean was calculated. *Plant spread*: The plant spread was measured in cross way (North-South and East-West) by measuring scale. The average of the two measurements was done and expressed in cm. *Number of suckers plant<sup>-1</sup>*: Number of suckers plant<sup>-1</sup> was recorded by counting suckers from 5 individual plant and then mean was calculated. *Leaf length*: The length of leaf was measured by a measuring scale from leaf base to the tip and was expressed in cm. *Number of branches plant<sup>-1</sup>*: Number of branches per plant was recorded by counting all the main branches from 5

**Table 2.** Effect of plant growth regulators on plant characteristics in chrysanthemum

Growth regulators (ppm)	Plant spread (cm)	Number of leaves	Leaf length (cm)
T <sub>1</sub>	22.9b	125b	11.00b
T <sub>2</sub>	25.0ab	135ab	12.00ab
T <sub>3</sub>	27.0a	140a	13.35a
T <sub>4</sub>	22.5b	117bc	9.90cd
T <sub>5</sub>	18.5c	95d	8.63d
T <sub>6</sub>	16.8cd	94d	8.47d
T <sub>7</sub>	19.0c	96d	10.89bc
T <sub>8</sub>	20.8bc	118bc	10.74bc
T <sub>9</sub>	21.0bc	119bc	10.80bc
T <sub>10</sub>	17.0cd	108c	9.20c
CV (%)	15.25	16.00	14.92

**Note:** T<sub>1</sub>-50 ppm GA<sub>3</sub>, T<sub>2</sub>-100 ppm GA<sub>3</sub>, T<sub>3</sub>-150 ppm GA<sub>3</sub>, T<sub>4</sub>-400 ppm CCC, T<sub>5</sub>-600 ppm CCC, T<sub>6</sub>- 800 ppm CCC, T<sub>7</sub>-250 ppm MH, T<sub>8</sub>-500 ppm MH, T<sub>9</sub>-750 ppm MH, T<sub>10</sub>-Control



**Figure 1.** Effect of growth regulators on the production of suckers in Chrysanthemum

plants and the mean was calculated. *Days to flowering*: It was recorded by counting the days from planting to first visibility of flower bud in the plant from each pot. *Stalk length*: Length of stalk was measured from base to the tip of the spike and was expressed in cm. *Number of flowers plant<sup>-1</sup>*: Number of flowers produced per plant was counted and recorded. *Flower size*: Flower size was measured in cross way following North-South and East-West position by a measuring scale and the average of the two measurements was done and expressed in cm for a single flower. Later on, the mean of individual flower size from 5 selected plants was calculated.

#### 2.2.8. Statistical analysis

The data recorded on different plant and floral parameters were statistically analyzed through analysis of variance with the help of 'MSTAT' software. The difference between treatment means were compared by Duncan's Multiple Range Test (DMRT).

### 3. RESULT AND DISCUSSION

#### 3.1. Effect of plant growth regulators on plant characteristics in chrysanthemum

Table 2 showed that the different plant characteristics exhibited differences among the ten treatments under study. In general, GA<sub>3</sub> treated plants showed significant improvement in plant spread compared to other treatment variables. The maximum spreading of plant (27.0 cm) was

observed when plants were treated with GA<sub>3</sub> @ 150 ppm which was closely followed by the application of GA<sub>3</sub> @ 100 ppm. The minimum plant spread (16.8 cm) was recorded in plants treated with CCC @ 800 ppm. Foliar application of GA<sub>3</sub> might have influence on cell division and cell elongation that resulting in enhanced vegetative growth of plants. In contrast, CCC may act as growth retardants and thereby inhibited biochemical processes resulting in less spreading of plants. The findings agree with those of Joshi et al. [24] and Kim et al. [25] in Chrysanthemum and Thu et al. [26] in carnation . The variation in number of leaf production was pronounced by the application of different growth regulators. However, the highest number of leaves (140) was produced by the application of GA<sub>3</sub> @ 150 ppm as foliar spray (Table 2). This was closely followed by the other concentrations of GA<sub>3</sub> @ 100 ppm. The effects of the GA<sub>3</sub> treatments were observed at par but significantly superior to the rest of the treatments. All the concentrations of CCC were at par recording minimum number of leaves. This is similar with the findings of Padmalatha et al. [27] who observed a greater number of leaves by the application of GA<sub>3</sub> and a smaller number of leaves by foliar application of CCC. The leaf length was also significantly increased with the application of GA<sub>3</sub> at different concentrations, of which GA<sub>3</sub> @ 150 gave the longest leaf length (13.35 cm). Leaf length highly reduced even in respect of control with the use of CCC growth regulators irrespective of concentrations. These findings confirmed that GA<sub>3</sub> acted as growth promoter and that of CCC as

growth retardants on different plant characters of chrysanthemum.

### 3.2 Effect of growth regulators on the production of suckers in *Chrysanthemum*

The higher number of suckers (33) per pot was produced when pots were treated with GA<sub>3</sub> @ 150ppm followed by GA<sub>3</sub> @ 100ppm (29), whereas, application of CCC at three different concentrations produced lower number of suckers (Figure 1). Use of CCC @ 600 and 800ppm produced the lowest number of suckers, which was much less than control treatment. This is in agreement with the findings of Mzabri et al. [28]. The higher number of sucker production by using GA<sub>3</sub> might be due to increase the number and size of leaves as a result of higher translocation of the photosynthates and eventually that would have been used for the production of propagules (suckers).

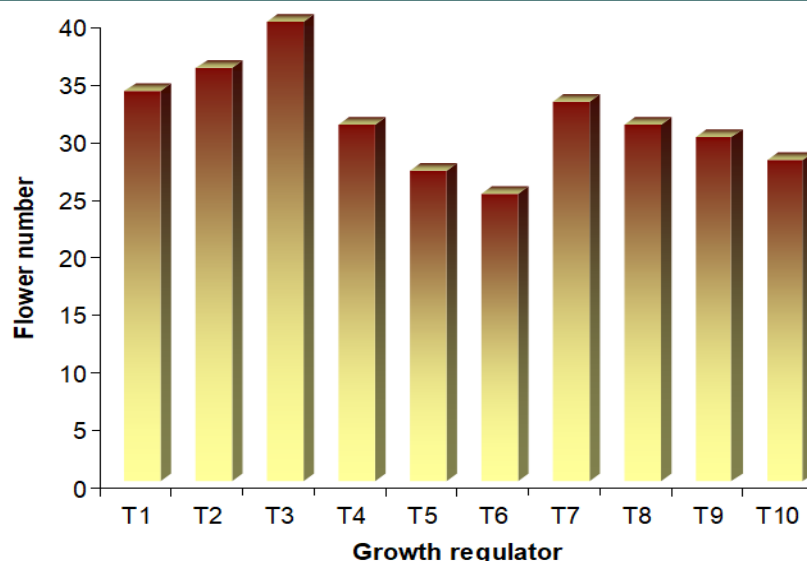
### 3.3 Effect of growth regulators on the production of flower in *Chrysanthemum*

In general, GA<sub>3</sub> at different concentrations produced the higher number of flowers (Figure 2). The highest number of flower (40) was recorded with 150 ppm GA<sub>3</sub>, which was significantly superior to those observed by spraying 100 ppm GA<sub>3</sub> and 50 ppm GA<sub>3</sub>. Application of 800 ppm CCC produced minimum number of flowers (25) per pot, which was at par with 600 ppm CCC (27) and 400 ppm CCC (31). This was in line with the findings of Kim et al. [25]. The increase in number of flowers for GA<sub>3</sub> treated plants might be due to

increase in number of leaves and leaf area compared to control and other treatments. This might have resulted in the production and accumulation of more photosynthates that were diverted to the sink (flower) and give increased number of flowers.

### 3.4 Effect of plant growth regulators on floral characteristics in *chrysanthemum*

Irrespective of concentrations, GA<sub>3</sub> significantly reduced the number of days to initiation of flowering (Table 3). The plants sprayed with 50 ppm GA<sub>3</sub> took 48 days to flower initiation, whereas, it took 70 days with 750 ppm MH. Among the growth regulators GA<sub>3</sub> caused faster initiation of flowering and ACC and MH delayed it in respect of control. Flower size was not significantly affected by the application of growth regulators at different concentrations (Table 3). However, it was recorded highest (7.40 cm) when plants were sprayed with 800 ppm CCC, whereas, lowest size (6.50 cm) was obtained with the application of 500 ppm MH. This was closely followed that obtained by the use of 750 ppm MH. This was in line with the findings of Padmalatha et al. [27] and Uddin et al. [29] in chrysanthemum. Here, food reserves may have been diverted to only fewer sinks that enhanced to produce bigger flowers. Length of flower stalk significantly increased when plant was treated with GA<sub>3</sub> regardless of different concentrations (Table 3). The application of 150 ppm GA<sub>3</sub> produced maximum length of flower stalk (15.0 cm), which was identical with those produced by 100 and 50



**Figure 2.** Effect of growth regulators on the production of flower in *Chrysanthemum*



**Table 3.** Effect of plant growth regulators on floral characteristics in Chrysanthemum

Treatment (ppm)	Days to flowering	Flower size (cm)	Stalk length (cm)
T <sub>1</sub>	48e	7.10	14.40a
T <sub>2</sub>	53d	7.20	14.70a
T <sub>3</sub>	55cd	7.30	15.00a
T <sub>4</sub>	58c	7.10	7.00d
T <sub>5</sub>	60bc	7.20	8.00cd
T <sub>6</sub>	62b	7.40	8.00cd
T <sub>7</sub>	65ab	6.80	9.00bcd
T <sub>8</sub>	68a	6.50	8.00cd
T <sub>9</sub>	70a	6.60	10.00bc
T <sub>10</sub>	57c	6.90	12.00b
CV (%)	13.64	17.50	12.41

Note: T<sub>1</sub>-50 ppm GA<sub>3</sub>, T<sub>2</sub>-100 ppm GA<sub>3</sub>, T<sub>3</sub>-150 ppm GA<sub>3</sub>, T<sub>4</sub>-400 ppm CCC, T<sub>5</sub>-600 ppm CCC, T<sub>6</sub>-800 ppm CCC, T<sub>7</sub>-250 ppm MH, T<sub>8</sub>-500 ppm MH, T<sub>9</sub>-750 ppm MH, T<sub>10</sub>-Control

ppm GA<sub>3</sub>. This was in line with the findings of Gabrel et al. [30]. This might be due to the fact that gibberellic acid promotes cell division and cell elongation resulting in longer stalks. The growth regulators CCC and MH at different concentrations gave the shorter stalk compared to control.

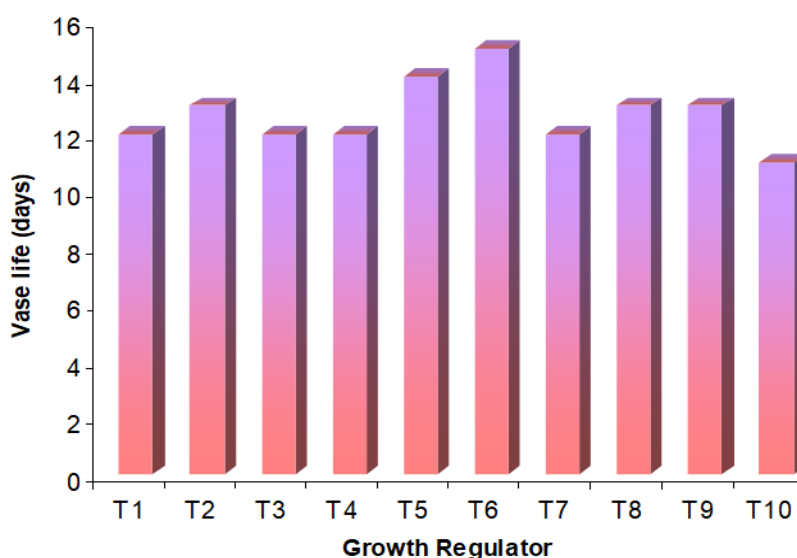
Padmalatha et al. [27] in chrysanthemum. This might be due to the fact that CCC acted as growth retardants that may reduce the cell size and stomatal opening and thereby reduce the area for transpiration for which it maintained better water balance.

### 3.5 Effect of growth regulators on the vase life of Chrysanthemum

Use of growth regulators showed an increasing vase life of flowers in respect of control (Figure 3). The maximum vase life of flowers was recorded for the treatment 800 ppm CCC (15 days), which was at par with 13 days vase life obtained by spraying 600 ppm CCC. This is in line with the findings of

### 4. CONCLUSION

The study revealed that growth regulators had significant impact on the plant characters, quality and vase life of flower. The performance of the chrysanthemum also depended on the concentration of the growth regulators. The GA<sub>3</sub> @ 150 ppm performed better than other concentrations,

**Figure 3.** Effect of growth regulators on the vase life of Chrysanthemum

whereas, CCC at all concentrations had some adverse effect on the plant performance. Therefore, it is concluded that GA<sub>3</sub> acted as growth promoter and that of CCC as growth retardants on yield and quality of chrysanthemum.

## AUTHOR INFORMATION

### Corresponding Author

**Ahasan Ullah Khan** — Department of Agroforestry and Environmental Science, Sylhet Agricultural University, Sylhet - 3100 (Bangladesh); Department of Entomology, Sylhet Agricultural University, Sylhet - 3100 (Bangladesh);

 <https://orcid.org/0000-0002-7029-8215>

Email: [ahasanullahsau@gmail.com](mailto:ahasanullahsau@gmail.com)

### Author

**Md. Ehsanullah** — Department of Entomology, Govt. shahid Akbar Ali Science and Technology College, Thakurgaon - 5120 (Bangladesh); Department of Entomology, Sylhet Agricultural University, Sylhet - 3100 (Bangladesh);

**Md. Kamruzzam** — Department of Soil Science, Govt. shahid Akbar Ali Science and Technology College, Thakurgaon - 5120 (Bangladesh);

**Sarah Tasnim** — Department of Genetics and Plant Breeding, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur - 1706 (Bangladesh); Department of Crop Genetics and Plant Breeding, Institute of Crop Science, Beijing -100081 (China);

## REFERENCES

- [1] M. C. Song, H. J. Yang, T. S. Jeong, K. T. Kim, and N. I. Baek. (2008). "Heterocyclic compounds from Chrysanthemum coronarium L. and their inhibitory activity on hACAT-1, hACAT-2, and LDL-oxidation". *Archives of Pharmacal Research*. **31** (5): 573–578. [10.1007/s12272-001-1195-4](https://doi.org/10.1007/s12272-001-1195-4).
- [2] A. U. Khan, M. A. R. Choudhury, A. U. Khan, S. Khanal, and A. R. M. Maukeeb. (2021). "Chrysanthemum production in bangladesh: significance the insect pests and diseases management: A review". *Journal of Multidisciplinary Applied Natural Science*. **1** (1): 25–35. [10.47352/jmans.v1i1.10](https://doi.org/10.47352/jmans.v1i1.10).
- [3] H. Hadizadeh, L. Samiei, and A. Shakeri. (2022). "Chrysanthemum, an ornamental genus with considerable medicinal value: A comprehensive review". *South African Journal of Botany*. **144** : 23–43. [10.1016/j.sajb.2021.09.007](https://doi.org/10.1016/j.sajb.2021.09.007).
- [4] J. Vijayakumari, V. S. Prabha, E. J. Rayan, T. L. S. Raj, and S. B. Antony. (2019). "Floristic diversity assessment of home garden in Palayamkottai region of Tirunelveli district, tamil nadu a means of sustainable biodiversity conservation". *International Journal of Trend in Scientific Research and Development*. **3** (3): 1484–1491. [10.31142/ijtsrd23390](https://doi.org/10.31142/ijtsrd23390).
- [5] C. Lu, Y. Li, J. Wang, J. Qu, Y. Chen, X. Chen, H. Huang, and S. Dai. (2021). "Flower color classification and correlation between color space values with pigments in potted multiflora chrysanthemum". *Scientia Horticulturae*. **283** : 110082. [10.1016/j.scienta.2021.110082](https://doi.org/10.1016/j.scienta.2021.110082).
- [6] E.-J. Suh, J. ki Hong, Y.-H. Lee, and D. C. Kim. (2020). "Overexpression of the Brassica rapa SRS7 gene in pot-type chrysanthemum [Chrysanthemum morifolium Ramat] reduces plant height". *Scientia Horticulturae*. **273** : 109634. [10.1016/j.scienta.2020.109634](https://doi.org/10.1016/j.scienta.2020.109634).
- [7] A. Van Der Ploeg and E. Heuvelink. (2006). "The influence of temperature on growth and development of chrysanthemum cultivars: A review". *Journal of Horticultural Science and Biotechnology*. **81** (2): 174–182. [10.1080/14620316.2006.11512047](https://doi.org/10.1080/14620316.2006.11512047).
- [8] T. Angami, L. Touthang, H. Kalita, R. Singh, B. Makdoh, A. Tasung, and P. Moirangthem. (2021). "Star anise (illicium griffithii hook. f. and thoms.): a tree spice from high altitude region of arunachal pradesh". *New Visions in Biological Science*. **2** : 123–129. [10.9734/bpi/nvbs/v2/4128f](https://doi.org/10.9734/bpi/nvbs/v2/4128f).
- [9] Z. D. Wang, C. Huang, Z. F. Li, J. Yang, B. H. Li, R. R. Liang, Z. J. Dai, and Z. W. Liu. (2009). "Chrysanthemum indicum ethanolic extract inhibits invasion of hepatocellular carcinoma via regulation of MMP/TIMP balance as therapeutic target". *Oncology*

- Reports*. **23** (2). [10.3892/or.00000650](https://doi.org/10.3892/or.00000650).
- [10] L. Y. Wu, H. Z. Gao, X. L. Wang, J. H. Ye, J. L. Lu, and Y. R. Liang. (2010). "Analysis of chemical composition of Chrysanthemum indicum flowers by GC/MS and HPLC". *Journal of Medicinal Plants Research*. **4** (5): 421–426.
- [11] Z. Shunying, Y. Yang, Y. Huaidong, Y. Yue, and Z. Guolin. (2005). "Chemical composition and antimicrobial activity of the essential oils of Chrysanthemum indicum". *Journal of Ethnopharmacology*. **96** (1–2): 151–158. [10.1016/j.jep.2004.08.031](https://doi.org/10.1016/j.jep.2004.08.031).
- [12] S. Shen, Y. Sha, C. Deng, X. Zhang, D. Fu, and J. Chen. (2004). "Quality assessment of Flos Chrysanthemi Indici from different growing areas in China by solid-phase microextraction-gas chromatography-mass spectrometry". *Journal of Chromatography A*. **1047** (2): 281–287. [10.1016/j.chroma.2004.06.129](https://doi.org/10.1016/j.chroma.2004.06.129).
- [13] Q. Ye and C. Deng. (2009). "Determination of camphor and borneol in Flos Chrysanthemi Indici by UAE and GC-FID". *Journal of Chromatographic Science*. **47** (4): 287–290. [10.1093/chromsci/47.4.287](https://doi.org/10.1093/chromsci/47.4.287).
- [14] W. Gao, Q. Meng, H. Luo, F. Chen, Y. Zhou, and M. He. (2020). "Transcriptional responses for biosynthesis of flavor volatiles in methyl jasmonate-treated Chrysanthemum indicum var. aromaticum leaves". *Industrial Crops and Products*. **147** : 112254. [10.1016/j.indcrop.2020.112254](https://doi.org/10.1016/j.indcrop.2020.112254).
- [15] A. U. Khan, M. Ehsanullah, Z. Samir, and Z. N. Vafa. (2021). "Effect of potting media on growth and yield of chrysanthemum". *Journal of Biology and Nature*. **13** (2): 16–22.
- [16] M. Ehsanullah, A. U. Khan, M. A. Alam, A. Singha, M. N. Karim, H. A. Shafi, and M. Kamruzzam. (2021). "Physio-Morphological traits and yield potentials of Chrysanthemum germplasm". *International Journal for Asian Contemporary Research*. **1** (1): 21–30.
- [17] T. Viyachaia, T. L. Abdullaha, S. A. Hassana, N. H. Kamarulzamanb, and W. A. W. Yusofc. (2015). "Development of cut chrysanthemum production in two soilless systems". *Agriculture and Agricultural Science Procedia*. **5** : 115–121. [10.1016/j.aaspro.2015.08.016](https://doi.org/10.1016/j.aaspro.2015.08.016).
- [18] J. P. Dutta and S. Ramadas. (2000). "Growth, development and flowering of chrysanthemum (*Dendranthema grandiflora* Tzelev.) as influenced by long- day exposures". *Orissa Journal of Horticulture*. **28** (1): 7–14.
- [19] S. Bañón, A. González, E. A. Cano, J. A. Franco, and J. A. Fernández. (2002). "Growth, development and colour response of potted *Dianthus caryophyllus* cv. Mondriaan to paclobutrazol treatment". *Scientia Horticulturae*. **94** (3–4): 371–377. [10.1016/S0304-4238\(02\)00005-5](https://doi.org/10.1016/S0304-4238(02)00005-5).
- [20] G. Sharma, M. Patanwar, P. Mishra, and N. Shukla. (2016). "Effect of plant growth regulators and pinching on garland chrysanthemum (*Dendranthema grandiflora* Tzvelev)". *International Journal of Bio-resource and Stress Management*. **7** (4): 766–769. [10.5958/0976-4038.2016.00118.4](https://doi.org/10.5958/0976-4038.2016.00118.4).
- [21] A. K. M. A. Islam, N. Anuar, Z. Yaakob, and M. Osman. (2010). "Improving plant growth and yield of jatropha (*Jatropha curcas* L.) Through Apical Bud Pinching". *International Journal of Fruit Science*. **10** (3): 281–293. [10.1080/15538362.2010.510422](https://doi.org/10.1080/15538362.2010.510422).
- [22] A. V. D. Dorajeero and A. N. Mokashi. (2012). "Yield and quality parameters of garland chrysanthemum (*Chrysanthemum coronarium* L.) as influenced by growth regulators/chemicals". *Indian Journal of Plant Sciences*. **1** (1): 16–21.
- [23] A. J. Uddin, T. Taufique, U. Mayeda, M. Z. K. Roni, and H. Mehraj. (2014). "Yield performance and phytochemical screening of three asparagus varieties". *Bangladesh Research Publications Journal*. **10** (22): 196–201.
- [24] J. Manoj, L. R. Verma, and M. M. Masu. (2009). "Performance of different varieties of chrysanthemum in respect of growth, flowering and flower yield under north Gujarat condition". *Asian Journal of Horticulture*. **4** (2): 292–294.
- [25] S. A. Kim, A. S. Lee, H. J. Hur, S. H. Lee, and M. J. Sung. (2020). "Preventive effects of *Chrysanthemum coronarium* L. extract on



- bone metabolism in vitro and in vivo”. *Evidence-Based Complementary and Alternative Medicine*. **2020** : 1–12. [10.1155/2020/6975646](https://doi.org/10.1155/2020/6975646).
- [26] H. T. M. Thu, A. H. Naing, H. Y. Jeong, and C. K. Kim. (2020). “Regeneration of genetically stable plants from in vitro vitrified leaves of different carnation cultivars”. *Plants*. **9** (8): 950. [10.3390/plants9080950](https://doi.org/10.3390/plants9080950).
- [27] T. Padmalatha, G. Reddy, R. Chandrasekhar, A. Shankar, and A. Chaturvedi. (2014). “Effect of foliar sprays of bioregulators on growth and flowering in gladiolus plants raised from cormels”. *Progressive Horticulture*. **46** (2): 288–294.
- [28] I. Mzabri, M. Rimani, N. Kouddane, and A. Berrichi. (2021). “Study of the effect of pretreatment of corms by different concentrations of gibberellic acid and at different periods on the growth, flowering, and quality of saffron in Eastern Morocco”. *Advances in Agriculture*. **2021** : 1–12. [10.1155/2021/9979827](https://doi.org/10.1155/2021/9979827).
- [29] A. F. M. Jamal Uddin, T. Taufique, A. F. Ona, S. Shahrin, and H. Mehraj. (2015). “Growth and flowering performance evaluation of thirty two chrysanthemum cultivars”. *Journal of Bioscience and Agriculture Research*. **4** (1): 40–51. [10.18801/jbar.040115.41](https://doi.org/10.18801/jbar.040115.41).
- [30] F. Gabrel, K. Mahmoud, and N. Ali El. (2018). “Effect of benzyl adenine and gibberellic acid on the vegetative growth and flowering of chrysanthemum plant”. *Alexandria Journal of Agricultural Sciences*. **63** (1): 29–40. [10.21608/alexja.2018.30051](https://doi.org/10.21608/alexja.2018.30051).